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Treatment Manual

Chemical Treatments

Fumigants • Methyl Bromide • Special Procedures for Container Fumigations Without a Tarpaulin

Contents

Methods and Procedures	page-2-8-2
Materials Needed	page-2-8-2
PPQ Officer Provides	page-2-8-2
Fumigator Provides	page-2-8-3
Preparing to Fumigate	page-2-8-3
Step 1—Selecting a Treatment Schedule	page-2-8-3
Step 2—Issuing a PPQ Form 523 (Emergency Action Notification)	page-2-8-4
Step 3—Determining Section 18 Exemptions and Sampling Requirements	page-2-8-4
Step 4—Selecting a Fumigation Site	page-2-8-4
Step 5—Arranging the Stack	page-2-8-6
Step 6—Arranging and Operating Fans	page-2-8-7
Step 7—Placing the Gas Introduction Lines	page-2-8-8
Step 8—Placing the Gas Sampling Tubes	page-2-8-8
Step 9—Measuring the Temperatures	page-2-8-9
Step 10—Measuring the Volume	page-2-8-10
Step 11—Calculating the Dosage	page-2-8-11
Step 12—Making a Final Check	page-2-8-11
Conducting the Fumigation	page-2-8-12
Step 1—Introducing the Gas	page-2-8-12
Step 2—Testing for Leaks	page-2-8-13
Step 3—Taking Concentration Readings	page-2-8-14
Step 4—Determining the Need to Add Gas and Adjust Exposure	page-2-8-16
Special Procedures for Adding Gas and Extending Exposure Period	page-2-8-17
Special Procedures for Fruits, Vegetables, or Perishable Commodities Using Schedule T101-a-1 or Equivalent	page-2-8-18
Special Procedures for Adding Gas to Oak Logs and Lumber Using T312 or Equivalent	page-2-8-23
Exhausting the Gas	page-2-8-23
Aerating the Enclosure	page-2-8-23
Responsibility for Aerating the Commodity	page-2-8-24
Materials Needed	page-2-8-24
Securing the Area	page-2-8-24
Wearing Respiratory Protection	page-2-8-25
Aerating Nonsorptive, Containerized Cargo	page-2-8-25
Step 1—Installing Exhaust System	page-2-8-25
Step 2—Aerating the Commodity	page-2-8-26
Aerating Sorptive Commodities in Containers	page-2-8-27
Step 1—Installing the Exhaust System	page-2-8-27
Step 2—Aerating the Commodity	page-2-8-27

Methods and Procedures

The procedures covered in this section provide PPQ Officers and commercial fumigators with the methods, responsibilities, and precautions for container fumigation without a tarpaulin.

A refrigerated container may be used for fumigations without a tarpaulin provided the following requirements are met:

- ◆ The container must be a refrigerated (reefer) container
- ◆ The container must have the two drainage holes removed at the doors. If damage will occur to the container by removal of these drains, the fumigator should obtain permission from the container manufacturer
- ◆ before proceeding.
- ◆ The container must have three gas monitoring leads to be located in the front-high, middle-middle and rear-low of the container. (The "rear" is considered to be at the doors.)
- ◆ The container must be packed (in some cases re-packed) so that one circulation fan can be placed in the front and one in the back. This will ensure at least 2' of air space above the commodity. Use fans which have the capacity to move a volume of air in cubic feet per minute equivalent to the total volume of the container. The rear fan (at the doors) has the gas introduction hose attached to it and is referred to as the gas introduction fan.
- ◆ The PPQ officer must visually inspect the container prior to fumigation to identify any possible areas of leakage for the fumigator to repair.
- ◆ Air exchange vents must be closed and taped if any openings are visible.

Materials Needed

PPQ Officer Provides

- ◆ Calculator (optional)
- ◆ Colorimetric tubes (Draeger/Kitagawa)
- ◆ Desiccant (Drierite®)
- ◆ Forms (PPQ Form 429 and APHIS Form 2061 if necessary)
- ◆ Halide leak detector
- ◆ Self-contained breathing apparatus (SCBA) or supplied air respirator to be used by PPQ officer

- ◆ Tape measure
- ◆ Thermal conductivity unit^{1, 2}
- ◆ Thermometer

Fumigator Provides

- ◆ Auxiliary pump for purging long gas sample tubes
- ◆ Carbon dioxide filter (Ascarite[®])
- ◆ Colorimetric tubes (Draeger/Kitagawa)
- ◆ Desiccant (Drierite[®], anhydrous calcium sulfate)
- ◆ Electrical wiring (grounded, permanent type), three prong extension cords
- ◆ Fans (circulation, exhaust, and introduction)
- ◆ Gas introduction line
- ◆ Gas sampling tubes (leads)
- ◆ Methyl bromide
- ◆ Scales or dispensers
- ◆ Self-contained breathing apparatus (SCBA) or supplied air respirator
- ◆ Tape
- ◆ Thermal conductivity unit^{3, 4}
- ◆ Volatilizer
- ◆ Warning signs

Preparing to Fumigate

Step 1—Selecting a Treatment Schedule

Select a treatment schedule to effectively eliminate the plant pest without damaging the commodity being fumigated.

Turn to the Treatment Schedule Index and look up the available treatment schedule(s) by commodity (example—apples, pears, or citrus) or by pest (example—Mediterranean fruit fly). Some

1 If fumigating oak logs or lumber for export, the unit must be capable of reading 400 oz.

2 T/C unit must be calibrated annually by the Oxford Plant Protection Laboratory. If requested, the Oxford Plant Protection Laboratory will calibrate a commercial fumigator's T/C unit.

3 If fumigating oak logs or lumber for export, the unit must be capable of reading 400 oz.

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commodities may have several treatment schedules. The “Fumigants—Methyl Bromide” section on Residual Effects lists those commodities which may be damaged by MB. Each treatment schedule lists the target pest or pest group (e.g., *Ceratitis capitata*, surface feeders, wood borers...), commodity, or both pest and commodity. If there is no schedule, contact the Oxford Plant Protection Center to see if a schedule is available under a FIFRA Section 18 Exemption. If a treatment is required, go to **Table 2.2.1**.

TABLE 2-8-1: Determine Reporting Requirements

If a treatment is required:	Then:
As a result of a pest interception	GO to Step 2
As a condition of entry	GO to Step 3

Step 2—Issuing a PPQ Form 523 (Emergency Action Notification)

When an intercepted pest is identified and confirmed by a PPQ Area Identifier as requiring action, issue a PPQ Form 523 (Emergency Action Notification) to the owner, broker, or representative. Be sure to list all treatment options when completing the PPQ Form 523 (Emergency Action Notification). Follow instructions in Appendix 1 for completing and distributing the PPQ Form 523 (Emergency Action Notification).

Step 3—Determining Section 18 Exemptions and Sampling Requirements

After selecting the treatment schedule, you will be able to determine which treatment schedules are FIFRA Section 18 Exemptions by the presence of broad, bold, vertical lines on the borders of the treatment schedule table listed in the reference. Some treatment schedules are only FIFRA Section 18 Exemptions at specific temperature ranges. Check the treatment schedule and temperature to determine if the fumigation will be a FIFRA Section 18 Exemption.

Food or Feed Fumigations

Residue monitoring by taking samples of the commodity prior to the start of the fumigation and after aeration is no longer required.

Step 4—Selecting a Fumigation Site

Consider the following factors in selecting a fumigation site:

- ◆ A well-ventilated, sheltered area
- ◆ Ability to heat area (in colder areas)
- ◆ A nonwork area which can be effectively marked and safeguarded or isolated
- ◆ Electrical power supply
- ◆ Water supply
- ◆ A well-lighted area

◆ Aeration requirements

A Well-Ventilated Area

Select sites which are well-ventilated. A well-ventilated site is required for exhausting gas.



Only open-air fumigations are allowed for non-tarped containers. Non-tarped containerized fumigations may not be conducted in a warehouse.

Some gas will escape from the container even in the best conditions. Ensure that the exhausted gas does not endanger people working outdoors. When treatments are conducted in a particular location on a regular basis, a permanent site should be designated. Select a site that is semi-sheltered such as the leeward side of a warehouse or pier.

A Nonwork Area

Select a secure area where traffic and people are restricted from entering and which is isolated from people working. You want a non-work area to help prevent accidents such as a forklift piercing a container and for other safety reasons. Consider either the entire structure area or an area which extends 30 feet from the container and is separated by a physical barrier such as ropes, barricades, or walls as the fumigation area. Some states, for example California, require a 100-foot perimeter around fumigation sites. If a wall of gas-impervious material is less than 30 feet from the container, the wall may serve as the edge of the secured area. Place placards clearly in sight of all who come near. Placards must meet label requirements regarding specific warnings, information, and language. Placards generally include the name of the fumigant, the fumigation date, time, and the name of the company conducting the fumigation. Restrict access to the fumigation area to the fumigator's employees and PPQ employees monitoring the treatment. Use rope or marker tape to limit access within 30 feet of the enclosure. Do not allow motor vehicles (includes forklifts) to operate within 30 feet of the enclosure during the fumigation and aeration periods.

The area outside the 30-foot perimeter is generally regarded as a safe distance from the container. Gas concentrations exceeding 5.0 ppm (TLV for MB) are seldom recorded by gas monitoring, except during aeration. PPQ Officers that work within the 30-foot perimeter must wear (and use) respiratory protection (SCBA), unless the gas levels are safe to breath and validated as safe by gas monitoring. The 30-foot perimeter is not specifically mentioned on the MB label, but is required for PPQ Officers.

When space is tight, it is permissible to overlap two or more adjoining 30-foot perimeters. However, there must be sufficient space for a person wearing SCBA to walk between the containers.

Electrical Power Supply

An adequate electrical source must be available to run the circulation fans and the T/C unit. A separate line should be available for the T/C unit. Electrical outlets must be ground and conveniently located in relation to the fumigation area. Do not use generators as a power source, except under emergency conditions.

Water Supply

A water supply is necessary for safety purposes. Water is necessary for washing off MB if the liquid form is spilled on someone. Water is also used to fill the volatilizer. If no permanent water is present on site, the fumigator must provide a portable, 5-gallon supply of clean water.

Well-Lighted Areas

The area should have adequate lighting for safety purposes and for ease in reading T/C units, thermometers, and for determining whether a container has holes or places where the MB may leak.

Aeration Requirements

Assuming that you've already restricted access and secured the fumigation area, you now must restrict access to the area where the exhaust duct extends beyond the enclosure. Before you start a fumigation, make sure the exhaust duct is located in a safe place. During the first 10 minutes of aeration, there should be no people within 200 feet down wind of the exhaust duct outlet. If it is impossible to restrict people from the area of aeration during regular work hours, consider aeration during another time of the day. When securing the duct outlet area, consider the direction of the wind. Face the duct outlet toward an open area, and away from people. Point the duct outlet upward to aid in dispersing the exhausted gas.

If an exhaust duct is not used, then a perimeter of 30 feet or more from the containers is usually regarded as a safe distance for personnel. However, for personal safety, gas levels should occasionally be monitored at greater distances, especially downwind. Experience provides the best guide.

Step 5—Arranging the Stack

Containerized Cargo

Containers should ordinarily not be loaded beyond 80 percent of their capacity. A space of 20 percent (18 inches) should be provided above the commodity. This allows a crawl space for placing the gas monitoring leads and fans, and to facilitate uniform gas distribution.

(Some restacking of cargo may be necessary to meet this requirement.) The commodity should be on a pallet to allow adequate space (at least 2 inches) below the commodity.

"Due to safety considerations, APHIS recommends that containers to be fumigated should not be stacked

Gas Penetration and Distribution

MB will penetrate most cargo easily; however, cargo may be packaged in an impermeable material.

Some of the more common types of impermeable materials are cellophane, plastic, wax coated materials, laminated, and waterproofed papers. Tight wooden packing cases are also relatively gastight. Impermeable materials will allow some gas to penetrate, but make it difficult to aerate and evacuate the gas. Remove, perforate, or open all impermeable materials.

For impermeable wrappers or containers, open the entire top or side and place the package with the open portion on the side.

Step 6—Arranging and Operating Fans

Containerized Cargo

There must be two circulation fans in the container, both placed on top of the stack. Place one fan at the doors (rear) and one fan in the front. The rear fan is the gas introduction fan and should be pointed into the container. The front fan is pointing in the opposite direction.

The electrical cords for the fans should be inserted through the drainage holes located at the doors. The fumigator must obtain approval from the owner of the container before removing the drains. The drains may be removed by any practical means available. Re-seal the holes using plumber's putty or similar water-proof caulking material to ensure minimal gas loss.

Turn on fans to make sure they work. Operate fans during gas introduction and for 30 minutes after the gas is introduced. If after taking gas concentration readings the fumigant is not evenly distributed, run the fans until the gas is evenly distributed as indicated by concentration readings (within 4 oz. of each other). Operate fans when adding gas, but only long enough to get even gas distribution.

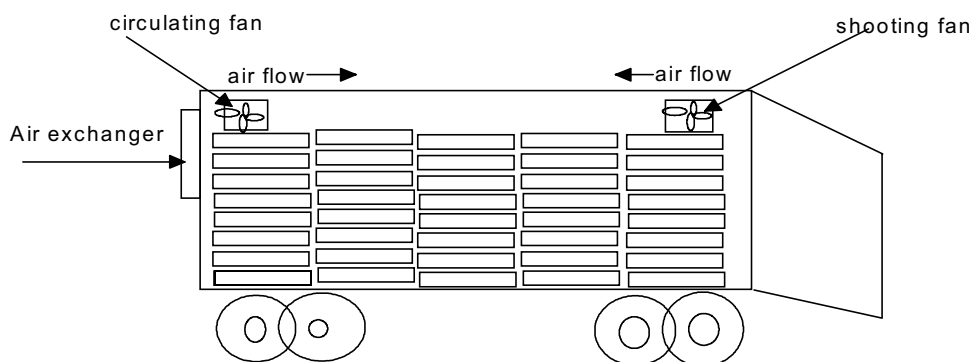


FIGURE 2-8-1 Fan Placement

The refrigeration unit may be run throughout the entire fumigation to enhance gas circulation and maintain pre-selected temperatures.



However, the ½ hour readings are at the minimum required concentration, or if gas has been added twice to the reefer, turn the refrigeration unit off for the remainder of the fumigation.

Step 7—Placing the Gas Introduction Lines

Containerized Cargo

Place the gas introduction line directly above the rear (door) fan. Attach the line to the top of the fan to prevent movement of the hose. The fan should be firmly attached to the cargo or have a base that prevents it from toppling (not a pedestal type). Place a piece of impermeable sheeting (example—plastic or rubberized canvas) over the commodity below and to the front of the gas supply line. The sheet will prevent any liquid MB from coming in contact with the cargo.

Step 8—Placing the Gas Sampling Tubes

Containerized Cargo

Place a minimum of three gas sampling lines in the container. Position the gas sampling tubes in the following locations:

- ◆ Rear low - at the doors, 3 inches above the floor
- ◆ Middle center—center of the load, midway from bottom to top of load
- ◆ Front high - at the extreme top of the load

The gas introduction and sampling lines should be inserted through the drainage holes located at the doors. The fumigator must obtain approval from the owner of the container before removing the drains. The drains may be removed by any practical means available. Re-seal the holes using plumber's putty or similar water-proof caulking material to ensure minimal gas loss.

Use gas sampling tubes of sufficient length to extend from the sampling position inside the container to at least 30 feet up-wind from the container. Have all the gas sampling tubes meet in one area for ease and safety in taking gas concentration readings. Do not splice gas sampling tubes. Before starting the fumigation, test all gas sampling tubes for tightness by connecting each gas sampling tube to the T/C unit and placing a finger over the far end of the gas sampling tube. The ball in the flow meter will fall to zero if the gas sampling tube connections are tight. Replace any defective gas sampling tubes. Before starting the fumigation, check for gas sampling tube blockage or pinching by connecting each tube for a short time. If the tube is blocked, the flow meter will drop sharply. Fix all gas sampling tubes securely in place in the container and label each one at the end where the gas concentration readings will be taken. By labeling each gas sampling tube, you will be able to record concentration readings easily.

Step 9—Measuring the Temperatures



Regardless of the commodity, never fumigate at temperatures below 40 °F.


If the commodity temperature drops below 40 °F after the fumigant has been added, do not include the time below 40 °F as part of the required exposure. Begin counting exposure time only after the temperature increases to at least 40 °F. However, in the case of perishable commodities, you must abort the fumigation immediately, unless it is feasible to add supplemental heat to bring the commodity temperature back to 40 °F or above. (Do not use an open flame or electric heating elements to increase the temperature.)

Determine the temperature to use in selecting the proper dosage rate:

- ◆ For fruits, pulpy vegetables, or logs use only the commodity temperature.
- ◆ For all other commodities use both the commodity and air temperature.

To take the temperature readings, use a bimetallic, mercury, or digital long-stem thermometer that has been calibrated. Use [TABLE 2-8-2: Determine the Temperature for the Proper Dosage Rate](#) [page-2-8-10](#) to determine which temperature to use when selecting the proper dosage rate for commodities other than fresh fruits, vegetables, or logs.

TABLE 2-8-2: Determine the Temperature for the Proper Dosage Rate

If the air temperature is:	And:	Then, for commodities other than fresh fruits or pulpy vegetables or logs and lumber:
Higher than the commodity temperature		Use the single lowest commodity temperature for determining the dosage rate (Do Not use the average commodity temperature).
Lower than the commodity temperature	By 9 degrees or less	Use the average of the single lowest air and commodity temperatures for determining the dosage rate (Never initiate a fumigation if any commodity temperature reads lower than 40°F.)
	By 10 degrees or more	

EXAMPLE: You are about to fumigate guar gum and the commodity temperature is 82 °F and the air temperature is 69 °F. Average the air and commodity temperatures to determine the dosage rate because the air is 13 degrees lower than the commodity temperature. The average of the two temperatures is 75.5 °F. Use 75 °F to determine the dosage rate.

If the commodity is fruits, pulpy vegetables, or logs, see the specific procedures that follow.

Fresh Fruits and Pulpy Vegetables

For fresh fruit and pulpy vegetables, insert the thermometer into the pulp. (for purposes of this paragraph, peppers are also included in the category of pulpy vegetables.) For commodities which have been refrigerated, probe the fruit that have the lowest pulp temperature. Again, fumigate only when the fruit pulp is at 40 °F or higher. However, if the commodity has no pulp (for example, peas, beans, grains, herbs, spices, etc.), take the temperature of the air space immediately surrounding the commodity as well as the commodity temperature. With these temperatures, use [TABLE 2-8-2: Determine the Temperature for the Proper Dosage Rate](#) [page-2-8-10](#) to determine the correct temperature for use when selecting the proper dosage rate

Step 10—Measuring the Volume

Using a 100-foot tape measure, carefully measure the length, width, and height of the enclosure. *Never* estimate the measurements. An error in measurement of as little as 12 inches can result in miscalculation of the dosage by as much as 15 percent. When measuring, round off to the nearest quarter foot (example—3 inches = .25 feet). In the case of fumigations of edible commodities, an error can result in an unacceptable level of residue on the commodity.

Formula for determining volume:

Length × width × height = volume in cubic feet

Record volume in Block 26 of the PPQ Form 429.

Step 11—Calculating the Dosage

Calculate dosage by doing the following:

1. Refer to the treatment schedule for the correct dosage rate (lbs./1,000 ft³) based on temperature (°F) (Step 10).
2. Multiply by the dosage (lbs./1,000 ft³) rate by the volume (ft³) to get the dosage in pounds.
3. Rules for rounding. Round to nearest ¼ pound.

Formula for calculating dosage:

$$\begin{aligned}\text{dosage (lbs.)} &= \text{volume(ft}^3\text{)} \times \text{dosage rate (lbs./1,000 ft}^3\text{)} \\ &= \frac{\text{volume(ft}^3\text{)} \times \text{dosage rate (lbs.)}}{1,000 \text{ ft}^3}\end{aligned}$$

Step 12—Making a Final Check

Just prior to introducing the gas, do the following:

- ◆ Turn on all fans and T/C unit to make sure they work.
- ◆ Warm up T/C unit at least 30 minutes before zeroing in.
- ◆ If contaminant, CO₂, is detected, test again with Ascarite[®]. If you get a zero reading, proceed. If you don't get a zero reading, suspect a leak.
- ◆ Start volatilizer and heat water to 200 °F or above. A minimum temperature of 150 °F is required at all times during the introduction process.
- ◆ Place fumigant cylinder with gas introduction line on scale and take initial weight reading. Make sure the gas introduction line is attached to the cylinder. After obtaining the correct weight, subtract the dosage to be introduced into the enclosure. After you have introduced the proper amount of gas, the scale will be balanced.
- ◆ Check that container is placarded and the area is secured. Only people working on the fumigation may be in the area.
- ◆ Check container to make sure it is free from holes where MB might leak.
- ◆ Check that all gas sampling tubes are labeled and are not crimped or crushed. Inspect tubes visually, or use an electric or Mityvac hand pump to check tubes. Either a fumiscope or vacuum pump may be used to test leads for unrestricted flow.



When conducting fumigations with methyl bromide, sulfuryl fluoride or phosphine, erroneous readings may occur if the monitoring leads become blocked or crimped. It would be impossible to install a new monitoring lead during a fumigation treatment. Therefore, to avoid an unsuccessful fumigation, you should test monitoring leads before the treatment begins.

The Oxford Plant Protection Center has developed the following procedure to detect blocked monitoring leads with the use of a Mityvac hand-held pump (for supplier, see **Vacuum Pump**, Appendix 8):

1. Prior to fumigant introduction, connect the Mityvac hand-held vacuum pump to a monitoring lead.
 2. Squeeze the handle on the Mityvac unit. If the lead is blocked, a vacuum will be indicated on the vacuum gauge of the Mityvac unit. (The handle should be squeezed two or three times for monitoring leads longer than 25 feet. The Mityvac hand-held pump has the capacity to attain and hold 25 inches of Hg vacuum and a minimum of 7 psig pressure.)
 3. Disconnect the Mityvac hand-held pump from the monitoring lead, and repeat this procedure for each monitoring lead. (Connect monitoring leads to the gas analyzer prior to fumigant introduction.)
- ◆ Check that there is enough gas in the cylinder and if necessary, that other cylinders are available.
 - ◆ Check the gas introduction line connections to make sure they are tight and free of leaks (wearing the SCBA).
 - ◆ Check all safety equipment, especially SCBA, is available and in working order.
 - ◆ Install Drierite[®] tube on gas sample line attached to the T/C unit and check to make sure granules are blue, if pink—replace Drierite[®]. If humidity is high, additional Drierite[®] tubes or frequent changes may be necessary.

Conducting the Fumigation

Step 1—Introducing the Gas



The acceptable air concentration level for methyl bromide (MB) is 5 ppm. A respirator (approved SCBA or MSHA/NIOSH) is required if the MB concentration level in the air is greater than 5 ppm at any time. You and the fumigator must use your SCBA while introducing the gas, checking for leaks, and when taking aeration readings.

Turn on all fans before introducing the gas. When using large cylinders of MB, have the fumigator open the cylinder valve slightly, then close the valve. With a halide detector, check all connections on the gas introduction line for leaks. If leaks are found, advise the fumigator tighten the connections and repeat the test. If no leaks are found, then open the valve to the point where 3 to 4 pounds of MB are being introduced per minute. The water temperature in the volatilizer should never go below 150 °F at any time during gas introduction. The water in the volatilizer may include an antifreeze and should be handled with the appropriate safeguards.



Don't touch the introduction line with your bare hands—you could get burned! Close the cylinder valve once the proper dosage has been introduced.

The fumigation time begins once all the gas has been introduced. Record the time gas introduction was started and completed in Block 32 on the PPQ Form 429. Run the fans for 30 minutes to achieve even gas distribution. Take the initial concentration reading 30 minutes after all the gas has been introduced.

When evacuating large cylinders, getting the final amount of gas out may take a long time. Consider taking a T/C unit reading 30 minutes after the gas was first introduced. If the gas distribution is even (all readings within 4 ounces of each other) and at a significantly high concentration, then turn off the fans. Running the fans longer may contribute to gas leakage. Allow the remainder of the gas to discharge with intermediate running of the fans. Normally, all the gas should be introduced within 30 minutes.



Do not begin counting fumigation time until all the gas has been introduced and valve on the MB tank is closed.

Step 2—Testing for Leaks

Wear the SCBA while checking for leaks. Use a halide detector to test for leaks before the 30 minute reading or anytime when the concentration level is unknown or above 5 ppm. Test around the perimeter of the container, and especially at the plugged drainage holes. When you detect leaks, have them sealed using tape.

If you detect excessive leakage (concentration readings of 50 percent or less of the minimum concentration) in a container which cannot be corrected in a practical way, do not attempt to correct the problem by adding more gas. Quickly evacuate the remaining gas from the enclosure, eliminate the problem, and construct a new enclosure. Aerate as usual following procedures on [page-2-8-14](#). Restart the fumigation in the new enclosure.



Commodities used for food or feed may not be re-treated. If commodities fall into this category, the only options are the following:

- ◆ Re-exported to another country if they will accept the shipment
- ◆ Destroy by incineration

Step 3—Taking Concentration Readings



Before obtaining readings, always purge sampling lines with a mechanical or hand pump. If you're using treatment schedule T101 or T104-a-1 to fumigate fresh fruit or vegetables, see "Special Procedures for Fruits and Vegetables" on [page-2-4-25](#).

Take concentration readings with a T/C unit to determine the gas concentration and distribution within the enclosure. Check desiccant tubes before each reading and change Drierite® if its color is pink. Depending upon the length of exposure period, take concentration readings at the following times:

- ◆ 30 minutes
- ◆ 2 hours
- ◆ 4 hours (optional)
- ◆ 6 hours (optional)
- ◆ 12 hours (optional)
- ◆ 24 hours⁵
- ◆ 36 hours (optional)
- ◆ 48 hours
- ◆ 72 hours

Any final concentration reading (see following example)

EXAMPLE: If the treatment schedule lists a 6 hour exposure period, then the 6 hour reading would be required and not optional as shown in Step 3. If the treatment schedule lists a 16 hour exposure period, you must take a 16 hour reading.



Avoid using hand-held two-way radios near the T/C unit. Using two-way radios near the T/C unit will interfere with an accurate concentration reading.

⁵ If fumigating oak logs or lumber for export, see "Special Procedures for Adding Gas to Oak Logs and Lumber."

Thirty Minute Reading

The 30 minute reading shows the initial concentration and distribution of gas. The 30 minute reading can indicate leakage, sorption, incorrect dosage calculation, or error in fumigant introduction—all of which require immediate attention. Concentration readings should not differ more than 4 ounces among the leads.

Two Hour Reading

In comparison with the 30 minute reading, the 2 hour reading also will indicate if the container is leaking or the commodity is sorbing gas. Readings more than 15 percent lower than the 30 minute reading will require close monitoring and possible corrective action.

EXAMPLE: Your dosage for the fumigation was 4 pounds (64 ounces). The 30 minute reading was 50 ounces (3.125 pounds). The 2 hour reading is 42 ounces (2.625 pounds). The 2 hour reading is more than 15 percent less than the 30 minute reading and would indicate that either a leak or sorption problem may exist. You would need to monitor the fumigation closely until the concentration level stabilizes.

Four, Six, Twelve, or Thirty-Six Hour Reading

Not required if previous readings are satisfactory and experience with similar fumigations indicate successful treatment can be expected. If either the 4, 6, 12, or 36 hour reading is the final reading, then you must take the reading. If you are unfamiliar with the treatment schedule, optional concentration readings may be necessary to ensure a successful fumigation.

Final Reading

The final reading is required for all container fumigations in order to determine if the fumigation has been successfully completed. You may start the final reading before the finishing time of the treatment so that aeration commences at the finishing time. Starting the final reading before finishing time is especially critical when fumigating perishables. Do not add gas after the final reading.

Additional Readings

Decide the need to take additional readings based on the following:

- ◆ Rate of gas concentration decrease
- ◆ Any condition which could change the gas concentration such as severe winds, or rain.

When concentration readings differ by more than 4 ounces, run the fans to equalize the gas and record readings on the APHIS 429. Generally, at the ½ hour reading, gas should be evenly distributed, and you should not have to restart the fans unless you added gas.

Severe winds (30 mph or higher including any amount severe enough to cause damage) are a good reason to take additional readings on an outdoor fumigation. Any sharp or unusual decreases of the readings in relation to previous readings is a clue to take corrective action and supplementary readings. Take additional readings every 30 minutes until problems are rectified. Adverse weather conditions may indicate the need for additional readings.

Sorptive commodities may also require additional concentration readings.

Step 4—Determining the Need to Add Gas and Adjust Exposure

Use the following table to determine when to add gas or extend the exposure period:

TABLE 2-8-3Determine the Need to Add Gas and Adjust Exposure

If the average T/C unit readings are:	And the schedule is:	Then:
Below the required minimum concentration	T101-a--1* or equivalent	ADD gas and extend fumigation. SEE “Special Procedures for Fruits and Vegetables” on page-2-4-25
	Other than T101a--1 or equivalent	ADD gas using “Special Procedures for Adding Gas and Extending Exposure” on page page-2-4-25
At or above required minimum concentration	T101-a--1* or equivalent	SEE page-2-4-19 for corrections at 0.5 hour and 2 hour readings
	Other than T101-a-1	No action necessary



Important

* T101-a-1 or equivalent treatment schedules are those schedules that are not greater than 2 hours long (exposure time), and the dosage rate is not greater than 4lbs per 1000ft³ anywhere on the schedule

Special Procedures for Adding Gas and Extending Exposure Period

Adding Gas to Commodities that are Fumigated Using Treatment Schedules Other Than T101-a-1 or Equivalent (may include perishables)



Important

T101-a-1 or equivalent treatment schedules are those schedules that are **not** greater than 2 hours long (exposure time), and the dosage rate is **not** greater than 4lbs per 1000ft³.



To avoid injuring the commodity, add fumigant using the following formula:
 $1.6 \times \text{number of oz. below minimum} \times \text{vol}/1,000 = \text{oz. of gas to add}$

When adding gas, these procedures must be followed:

1. Heat water in volatilizer.
2. Turn on fans.
3. Take weight of the cylinder.
4. With your SCBA on, open valve on cylinder and introduce the gas.
5. Close valve when the weight of the cylinder indicates that the needed amount of gas has been added.
6. Record quantity of fumigant added in Block 34 and the additional fan time in Block 30 of the PPQ Form 429.

Note the time the fumigator started introducing additional gas and the time the fumigator finished introducing gas and record in Block 40 (Remarks) of the PPQ Form 429. Run the fans until there is even gas distribution throughout the stack. Turn off fans, then take a concentration reading 30 minutes after the gas has been introduced. If all readings are above minimum concentration levels, then proceed as usual with the remaining scheduled concentration readings.

Excessive leakage (concentration readings are less than 50 percent of minimum) in any one container which cannot be eliminated in a practical way must **not** be corrected by the addition of MB. "Quickly evacuate remaining gas from the container, eliminate the problem, and start a new treatment



Commodities used for food or feed may not be re-treated. If commodities fall into this category, the only options are the following:

- ◆ Return to the country of origin
- ◆ Re-export to another country if they will accept the shipment
- ◆ Destroy by incineration

Extending the Exposure Period for Food, Nonfood, Feed, or Nonfeed Commodities

Use the following table to determine how long to extend the exposure period.

TABLE 2-8-4: Determine the Extended Exposure Period

If the exposure time is:	And the reading is below minimum by:*	Then extend exposure:
Less than 12 hours	10 oz. or less	10 percent of the time lapse since the last acceptable reading
	11 oz. or more	30 minutes
12 hours or more	10 oz. or less	10 percent of the time lapse since the last acceptable reading
	11 oz. or more	2 hours or 10 percent of time lapse since last acceptable reading, whichever is greater

*If reading is 50 percent below minimum or less, then abort the treatment. For example, if the minimum reading is 38 ounces then the reading 50 percent below the minimum is 19 ounces [38 ounces – (38 ounces × .50) = 19 ounces]. (See the following special procedures for fruits and vegetables using T101 or equivalent.)

Special Procedures for Fruits, Vegetables, or Perishable Commodities Using Schedule T101-a-1 or Equivalent

Use these instructions only for fruits and vegetables being fumigated under treatment schedule T101-a-1 or equivalent.



Fresh fruits and vegetables are sensitive to MB so you should double check volume calculations and dosage measurements to avoid accidental overdoses. If any 30 minute readings are 50 percent or more above the minimum concentration, it indicates a miscalculation of the dosage. Include a brief report on the PPQ Form 429 stating possible reasons for the overdose. Exposure periods are decreased for fumigations where concentration readings are much higher than required. See table on the following pages to determine when to reduce exposure periods.

Use Table 2-2-6 and **Table 2-2-7** on the following pages for fresh fruits and vegetables to determine if you need to add gas or extend or decrease the exposure time. Average your concentration readings before using the tables. Select the proper table based on the time of the T/C unit concentration reading (30 minutes or 2 hours).



These tables apply **only** to those T101 schedules lasting 2 hours or less at a dosage rate of 4lbs/1000ft³ or less. They do not apply to schedules of longer duration.

Adding Gas



To avoid injuring the commodity, add fumigant using the following formula:
 $1.6 \times \text{number of oz. below minimum} \times \text{vol}/1,000 = \text{oz. of gas to add}$

When adding gas, these procedures must be followed:

1. Heat water in volatilizer.
2. Turn on fans.
3. Take weight of the cylinder.
4. With your SCBA on, open valve on cylinder and introduce the gas.
5. Close valve when the weight of the cylinder indicates that the needed amount of gas has been added.
6. Record quantity of fumigant added in Block 34 and additional fan time in Block 30 of the PPQ Form 429.

Note the time the fumigator started introducing additional gas and the time the fumigator finished introducing gas and record in Block 40 (Remarks) of the PPQ Form 429. Run the fans until there is even gas distribution throughout the stack. Turn off fans, then take a concentration reading 30 minutes after the gas has been introduced. If all readings are above minimum concentration levels, then proceed as usual with the remaining scheduled concentration readings.

TABLE 2-8-5: Determine Gas Concentration Values and Corrections for Fruits and Vegetables at the 30 Minute Reading of T101-a-1 or Equivalent Schedules

If the schedule is:	And the minimum concentration reading (oz.) in the schedule is:	And the average concentration reading (oz.) is:	Then:
40-49 °F 4 lbs for 2 hrs	48	73 or higher ¹	EVACUATE excess gas immediately
		65 or greater*	REDUCE exposure by 15 minutes
		64-48	TAKE 2 hour reading as scheduled
		47 or lower	1. ADD gas, and 2. EXTEND exposure 15 minutes
50-59 °F 3 lbs for 2 hrs	38	58 or higher*	EVACUATE excess gas immediately
		52 or greater	REDUCE exposure by 15 minutes
		51-38	TAKE 2 hour reading as scheduled
		37 or lower	1. ADD gas, and 2. EXTEND exposure 15 minutes
60-69 °F 2.5 lbs for 2 hrs	32	49 or higher*	EVACUATE excess gas immediately
		48 or greater	REDUCE exposure by 15 minutes
		47-32	TAKE 2 hour reading as scheduled
		31 or lower	1. ADD gas, and 2. EXTEND exposure 15 minutes
70-79 °F 2 lbs for 2 hrs	26	40 or higher*	EVACUATE excess gas immediately
		37 or greater	REDUCE exposure by 15 minutes
		36-26	TAKE 2 hour reading as scheduled
		25 or lower	1. ADD gas, and 2. EXTEND exposure 15 minutes

TABLE 2-8-5: Determine Gas Concentration Values and Corrections for Fruits and Vegetables at the 30 Minute Reading of T101-a-1 or Equivalent Schedules (continued)

If the schedule is:	And the minimum concentration reading (oz.) in the schedule is:	And the average concentration reading (oz.) is:	Then:
80-89 °F 1.5 lbs for 2 hrs	19	30 or higher*	EVACUATE excess gas immediately
		27 or greater	REDUCE exposure by 15 minutes
		26-19	TAKE 2 hour reading as scheduled
		18 or lower	1. ADD gas, and 2. EXTEND exposure 15 minutes

- 1 If concentration reading is more than 50 percent above the minimum concentration reading, it indicates that something is radically wrong and an immediate check should be made to determine the cause and to correct it.

TABLE 2-8-6: Determine Gas Concentration Values and Corrections for Fruits and Vegetables at the 2 Hour Reading of T101-a-1 or Equivalent Schedules

If the schedule is:	And the average concentration reading at 2 hours is:	Then do not add gas, but:
40-49 °F 4 lbs for 2 hours	38 and above	AERATE commodity (see page-2-4-29)
	37-28	EXTEND exposure by 15 minutes
	27-25	EXTEND exposure by 30 minutes
50-59 °F 3 lbs for 2 hrs	29 and above	AERATE commodity (see page-2-4-29)
	28-24	EXTEND exposure by 15 minutes
	23-21	EXTEND exposure by 30 minutes
60-69 °F 2.5 lbs for 2 hrs	24 and above	AERATE commodity (see page-2-4-29)
	23-21	EXTEND exposure by 15 minutes
	20-18	EXTEND exposure by 30 minutes
70-79 °F 2 lbs for 2 hrs	19 and above	AERATE commodity (see page-2-4-29)
	18-16	EXTEND exposure by 15 minutes
	15-13	EXTEND exposure by 30 minutes
80-89 °F 1.5 lbs for 2 hrs	14 and above	AERATE commodity (see page-2-4-29)
	13-12	EXTEND exposure by 15 minutes
	11-10	EXTEND exposure by 30 minutes

Special Procedures for Adding Gas to Oak Logs and Lumber Using T312 or Equivalent

After taking the 24 hour concentration reading, if necessary, add gas to bring the concentration level up to 240 ounces. Subtract the 24 hour concentration reading from 240 to determine how many ounces the concentration is below 240 ounces. Use the following formula in calculating how much gas to add:

$$1.6 \times \text{number of oz. below 240} \times \text{volume in ft}^3 / 1,000 \text{ ft}^3 = \text{oz. of gas to add or}$$

$$\frac{\text{oz. of gas to add}}{16 \frac{\text{oz.}}{\text{lbs.}}} = \text{pounds (lbs.) of gas to add}$$

EXAMPLE: You're fumigating a 10,000 ft³ enclosure of oak logs for export. At the 24 hour reading, the T/C unit readings indicate a 160 oz. concentration level. To determine how much gas to add, do the following:

$$240 \text{ oz.} - 160 \text{ oz.} = 80 \text{ oz. below 240 oz.}$$

$$1.6 \times 80 \text{ oz.} \times 10,000 \text{ ft}^3 / 1,000 \text{ ft}^3 = 1,280 \text{ oz. or}$$

$$\frac{1,280 \text{ oz.}}{16 \frac{\text{oz.}}{\text{lbs.}}} = 80 \text{ pounds (lbs.) of gas to add}$$

Take concentration readings 30 minutes after adding gas and record on the PPQ Form 429.

Exhausting the Gas

Exhaust the gas at the completion of the exposure period. If the treatment schedule is a FIFRA Section 18 Exemption, then you must monitor the aeration of the commodity. Use the following table to determine the need to monitor the aeration of the fumigation.

TABLE 2-8-7Determine the Need to Monitor Aeration

If the treatment schedule is:	Then:
A FIFRA Section 18 Exemption	MONITOR the aeration of the commodity. FOLLOW "Aerating the Enclosure" steps which follow.
A labelled treatment	RELEASE the commodity and RELEASE the fumigation to the fumigator for aeration.

Aerating the Enclosure

Aeration procedures are designed to provide safe working conditions during the aeration period and to assure that commodities are safe for handling, storage, and transportation. A fumigant must be aerated in accordance with Environmental Protection Agency (EPA) label requirements, the Occupational Safety and Health Administration (OSHA), and the PPQ Treatment Manual.

Aeration of fumigated structures and ships are covered within those particular sections.

Responsibility for Aerating the Commodity

The label requires that at least two people trained in the use of the fumigant must be present at all times during gas introduction, treatment, and aeration. The PPQ officer, however, is not required to be continuously present at the fumigation site throughout the aeration process unless specified by the label or by State or local regulations.

If the fumigation is performed under a Section 18 Exemption, then a PPQ officer must be present at the initiation of aeration and to verify the final aeration readings.

TABLE 2-8-8: Determine Responsibility for Aerating the Commodity

If the Treatment Schedule is:	Then:
A FIFRA Section 18 Exemption	1. MONITOR the aeration of the enclosure, and 2. USE the table on page-2-4-31 to determine which aeration procedure to follow
A labeled Treatment Schedule	1. RELEASE the fumigation to the fumigator to aerate according to label instructions and the conditions of the compliance agreement. 2. RELEASE the commodity.

Materials Needed

The following materials will be needed to aerate the enclosure:

- ◆ SCBA⁶
- ◆ Colorimetric tubes* (Draeger or Kitagawa for example)
- ◆ Exhaust fan⁷
- ◆ Exhaust duct**
- ◆ Danger signs**
- ◆ Materials for limiting access to area (barricades, rope)**
- ◆ PPQ Form 429

The following procedures apply to the aeration of all container fumigations.

Securing the Area

Assuming that you have already restricted access and secured the fumigation area, you now must restrict access to the area where the exhaust duct extends on the ground beyond the enclosure.

⁶ Materials required for both PPQ and commercial fumigator.

⁷ Materials to be furnished by the commercial fumigator.



During the first 10 minutes of aeration, it is recommended that no people should be within 200 feet of the exhaust duct outlet.¹

- 1 If this buffer zone is regulated by the State or municipality where the fumigation takes place, local regulations must be followed.

If it is impossible to restrict people from the area of aeration during regular work hours, consider aeration during another time of the day. When securing the duct outlet area, consider the direction of the wind. Face the duct outlet toward an open area, and away from people. Point the duct outlet upward to aid in dispersing the exhausted gas.

Advise the fumigator use a physical barrier such as ropes, barricades, or walls to secure the area.

Placard the secure area near the exhaust outlet with the appropriate DANGER/PELIGRO signs. Make sure the placards meet the appropriate fumigant label or labeling requirements. The skull and crossbones should be present as well as “AREA UNDER FUMIGATION, DO NOT ENTER/NO ENTRE”; date of the fumigation; name of the fumigant used; and the name, address, and telephone number of the fumigator.

Unless you authorize their use, do *not* allow motorized vehicles to operate within the secure area.

Wearing Respiratory Protection

The fumigator and the PPQ officer monitoring the aeration must wear approved respiratory protection (SCBA, air supplied respirator, or a combination unit) when:

- ◆ Installing the exhaust system
- ◆ Opening the container for aeration
- ◆ Any time during the aeration process when a risk of exposure to concentrations above 5 ppm exists. This includes any time the concentration is unknown.

TABLE 2-8-9Determine the Aeration Procedure

If:	And:	And:	Then:
Nonsorptive	Containerized	—————➔	GO to page-2-4-32
Sorptive, including yams and chestnuts	Containerized	—————➔	GO to page-2-4-33

Aerating Nonsorptive, Containerized Cargo

Step 1—Installing Exhaust System

Advise the fumigator:

- ◆ Install an exhaust fan (minimum of 5,200 cfm capacity) to a 16 inch, or greater, diameter duct located at the floor near rear doors of the container.
- ◆ Or, as another option, install an air introduction duct system consisting of a 3,750 cfm, or greater, fan attached to a 12 inch, or larger, duct which reaches two-thirds of the length of the container at the top of the load. Have the ducts installed prior to the start of the fumigation. Extend the exhaust duct at least 30 feet beyond the container.



(1) Volume of enclosure (in cubic feet) divided by the sum of cubic feet per minute (cfm) of the exhaust fan(s) or exhaust blower equals the number of minutes required per complete gas volume exchange. (2) Sixty minutes divided by the number of minutes per gas volume exchange equals the number of complete gas exchanges per hour. The result should be in the range of 4 to 15. The faster the rate of aeration the better, particularly for perishable commodities. If the exhaust flow is connected to a methyl bromide recovery system, this device must not impede the flow rate to less than 4 volumes per hour.

Step 2—Aerating the Commodity

Advise the fumigator:

1. Connect the exhaust duct to the exhaust fan.
2. Start the exhaust fan(s)
3. Aerate for 3 hours.
4. Stop the aeration fans.
5. Use a colorimetric tube to take a concentration reading in the exhaust duct.

After the fumigator takes the concentration reading, you must record the date, concentration reading, and time in Block 39 of PPQ Form 429. Then use the following table to determine when to release the commodity.

TABLE 2-8-10

If the gas concentration level is:	Then:
5 ppm or less	RELEASE the commodity
6 ppm or more	1. CONTINUE aeration until the concentration is 5 ppm or less ¹ , then 2. RELEASE the commodity

¹ Concentration reading must be taken 4 feet from floor and 1 foot inside stack at two locations between the cartons but not inside the cartons.

Aerating Sorptive Commodities in Containers

Step 1—Installing the Exhaust System

Advise the fumigator:

- ◆ Install an exhaust fan (minimum of 5,200 cfm capacity) to a 16 inch or greater diameter duct located at the floor near rear doors or the container.
- ◆ Or, as another option, install an air introduction duct system consisting of a 3,750 cfm or greater fan attached to a 12 inch or greater duct which reaches two-thirds of the length of the container at the top of the load. Have the ducts installed prior to the start of the fumigation. For outdoor fumigations, extend the exhaust duct 30 feet beyond the container.

Step 2—Aerating the Commodity

Outdoors

Advise the fumigator:

1. Complete installation of exhaust duct and begin exhaust fan.
2. Start the circulation and air introduction fans. Sorptive commodities generally require 12 hours or longer to aerate. Since sorptive commodities vary in their rates of desorption, aeration may be completed in less than 12 hours. Require a minimum of 4 hours aeration for all sorptive commodities.
3. Stop the circulation fans and take concentration readings with colorimetric tubes 4 feet from the ground and 1 foot inside the outer edge of the stack between the cartons but not inside the cartons. One location is sufficient.

After the fumigator takes the concentration reading, you must record the date, concentration reading, and time in Block 39 of PPQ Form 429. If you are not at the fumigation site, have the fumigator call and give you the information. Then use the following table to determine when to release the commodity.

TABLE 2-8-11Determine When to Release the Commodity

If the gas concentration level is:	Then:
5 ppm or less	RELEASE the commodity
6 ppm or more	1. CONTINUE aeration and take concentration readings until the level is 5ppm or less, then 2. RELEASE the commodity

